Oceanic Tidal Friction.

IN equation (26) of a paper in the current number of the Proceedings of the Royal Society (93 A, pp. 348-59) Mr. R. O. Street has given an expression for the rate of dissipation of energy in the oceanic tides which is probably the best yet obtained; it is proportional to the square root of the viscosity and to the square of the surface velocity. In view, however, of the uncertainty of many of the data involved, which he carefully states, some further discussion of the subsequent numerical application seems desirable. At the end of the paper it is shown that a periodic surface velocity with a maximum of 2 ft. per second all over the ocean, with a viscosity of 1.4×10^{-5} ft.²/sec., would account for a retardation of the earth's rotation of amount $4'$ of arc per century per century. Now it is easy to find from equations (11) on p. 303 of Lamb's "Hydrodynamics" that the surface velocity in mid-ocean for a tide of height 2 ft. is only of order 0.04 ft. per second; on the other hand, the effective viscosity is very much increased on account of turbulence. The available data on this question are scanty, but the writer has shown elsewhere (*Monthly Notices of R.A.S.*, vol. lxxvi., 1916, p. 512) that the effective viscosity in the ocean is probably of order $4 \text{ cm.}^2/\text{sec.} = 4.4 \times 10^{-2} \text{ ft.}^2/\text{sec.}$ Thus Street's retardation must be multiplied by $(0.02)^2(300)^{\frac{1}{2}}$, giving $0.02'$ per century per century, which is inappreciable. No great part of the observed lunar acceleration can therefore be attributed to tidal friction in mid-ocean. The dissipation in shallow regions near the coast may be greater, as the velocity is greater there, but in view of the limited area concerned the total is unlikely to be important. As the retardation of the earth's rotation that is required to account for the lunar acceleration is about 10.4 per century per century (*ibid.*, vol. lxxvii.; 1917, p. 453), Street's result on the whole confirms those of the earlier investigators, who regarded oceanic tidal friction as very small in amount, and were disposed to refer all the dissipation, if any, to the bodily tides.

HAROLD JEFFREYS.

St. John's College, Cambridge.

Gravitation and Thermodynamics.

ATTENTION has been given in NATURE to various deductions from the results of Dr. P. E. Shaw's experiments on "The Newtonian Constant of Gravitation as affected by Temperature" (*Phil. Trans.*, A, 544, 1916). So far as the present writer is aware, attention has not been directed to the suggestive remarks of the late Prof. G. F. Fitzgerald, to be found in his Helmholtz memorial lecture (*Transactions Chemical Society*, 1896, pp. 889-95). In the course of his reference to Helmholtz's contribution to the theory of vortex motion, Fitzgerald remarks:—"It is difficult to weigh hot bodies accurately, and, in consequence, there does not seem to be any conclusive proof that the weight of a body does not change with its temperature. If it does not do so by a measurable amount, the simple vortex ring theory of matter can hardly be true."

J. S. G. THOMAS.

709 Old Kent Road, S.E.15, July 4.

The First New Moon in the Year 1 B.C.

IN making some computations last March about the occurrence of new moon, an error of statement was discovered in the ninth edition of the "Encyclopædia Britannica" under "Calendar," vol. iv., p. 594, and repeated in the eleventh edition, vol. iv., p. 993; it is also given in Barlow and Bryan's "Mathematical Astronomy," p. 215. The erroneous statement is that new moon occurred on January 1 in 1 B.C. New moon in January, 1 B.C., occurred on January 25, 12h. 26m. Jerusalem Mean Civil Time.

Dominion Observatory, Ottawa. OTTO KLOTZ.

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PHOTOGRAPHS OF AURORA.

ATTEMPTS to measure the height of aurora were made prior to the end of the eighteenth century, and have been repeated at intervals since that date. The most direct method is obviously to determine the parallax as given by synchronous observations at two stations a sufficient distance apart. In the case of the earlier attempts to apply this method, it was only by the merest accident that observations would have been taken simultaneously, and even in that event it was improbable that the same point would have been selected for observation. Thus it was impossible to feel any great confidence in the older results, though, as a matter of fact, some of them were probably not far wrong. After the invention of the telephone, it became possible for two observers a sufficient distance apart to make simultaneous observations with theodolites, but some uncertainty necessarily prevailed as to the identity of the points selected for observation. Observations made in this way at Godthaab, in Greenland, with a 5.8-kilometre base, discussed by Prof. Paulsen thirty years ago, gave for the lower edge of aurora heights varying from 0.6 to 67.8 km., the average being only some 20 km. At Godthaab, however, the parallax was too small to measure in some 20 per cent. of the cases.

Towards the end of last century several people succeeded occasionally in attempts to photograph aurora, and in 1909 Prof. Carl Störmer, of Christiania, devised a satisfactorily successful method of securing photographs with only a few seconds' exposure, and in 1910 he and his assistants secured a good many pairs of photographs from two stations 5 km. apart, near Bossekop, in the north of Norway.

In 1913 Prof. Störmer took a much larger number of photographs, employing a longer base, observations being made at Bossekop and Store Korsnes, $27\frac{1}{2}$ km. apart. His photographs include known stars as well as the aurora. An auxiliary photograph of the face of a watch gives the exact time, and thus the position of the star. A series of corresponding points can usually be recognised in the two photographs, and the geographical position as well as the height of the aurora—whether an arc, a band, a curtain, or a ray—can be calculated. The accompanying figures are reproductions of two pairs of photographs obtained by Prof. Störmer and his assistant in 1913.

Prof. Störmer has recently discussed in *Terrestrial Magnetism* a number of the measurements made on the photographs which he took in 1913. The majority of his calculated heights refer to the lower edge of the aurora, partly, no doubt, because it is usually the best defined, and partly because it possesses especial interest in connection with the theory which he supports, viz. that aurora arises from electrical corpuscles discharged from the sun. On this theory, the lower the visible limit of aurora, the more penetrating the discharge. Out of about 2500 height